SECTION IV

IMPACTS, MITIGATION MEASURES and UNAVOIDABLE ADVERSE IMPACTS

4.1 EARTH

4.1.1 Impacts of the Proposed Master Plan

Construction would include excavation and filling during grading activities, construction of building foundations and stormwater facilities, and the installation of underground utilities. Preliminary earthwork estimates indicate that approximately 123,300 cubic yards of cut and about 56,000 cubic yards of fill would occur on-site.

Several sensitive geologic areas of the site, characterized by steep slopes and erosion prone soils, create a small potential for minor adverse impacts. As noted in Section *3.1 Earth* of this Draft EIS, these areas are not identified on King County's Sensitive Areas Map Folio. They would, however, meet the definition of erosion, steep slope, or landslide areas based on the criteria contained in KCC 21A.24. To address potential impacts, which are described below, earthwork construction standards and recommendations for foundation design would be developed as part of a geotechnical design report in conjunction with final design. Mitigation measures are also addressed in subsection 4.1.3 below; many of these reflect standard construction practices or are required by King County regulations.

Erosion

As noted previously, erosion hazard areas are not identified in the Sensitive Areas Map Folio. Several areas of the Greenbridge site could meet the code's definition of erosion hazard areas, however, based on underlying geology (rather than soil type). These areas include: (1) slopes on the east side of the development; (2) points of discharge for stormwater facilities for sub-basins DR-2 and DR-3 in the Duwamish River basin (see Water Element); (3) point of discharge for the Mallard Lake sub-basin ML-2 (see section *4.2 Water Resources* of this Draft EIS)*;* and (4) slopes on the west side of the development.

Construction

Construction activities can potentially cause increases in erosion potential unless mitigated. Soil exposed during construction is highly vulnerable to erosion, especially during and following removal of ground cover and demolition of buildings. Demolition would remove structures and other hard-surfaced areas presently providing protection. In addition, increased volume, rate, or duration of stormwater runoff could increase potential erosion in defined watercourses. Stream corridors or nearby waterbodies could also experience increased sedimentation during the construction period. Soil additives such as CKD or CTB may be used during the construction phase. If these elements are used, they will be in compliance with applicable King County Codes and Best Management Practices.

Operation

In general, the potential for erosion would be significantly reduced after construction. Soils exposed and disturbed during construction would be paved, covered by structures, or revegetated with landscaping or grass lawns. Hard-surfaced areas would not be subject to erosion; the erosion potential of landscaped and lawn areas would be similar to pre-development conditions.

The primary risk of erosion following construction would be in areas where stormwater is concentrated and/or allowed to flow uncontrolled over erosion prone areas. These locations are described above. Stormwater system design would generally address these potential impacts. Stormwater from roof-drains would either be routed to perforated stub-outs or stormwater control facilities and off would not likely flow onto erosion hazard areas within or adjacent to the project site. During construction in hot weather it is common practice to use silt fences and lined diversion trenches to control runoff siltation and protect adjacent areas. Discharge from drainage facility RD-DR-2B, in the southeastern portion of the site, would be tightlined to the base of the slope. If not tied directly into the existing stormwater drain system flowing toward Meyers Way, it could be necessary to install an energy dissipater at the outlet. Leakage could potentially occur from either RD-DR-2A or RD-DR-2B and flow to down-gradient erosion hazard areas, potentially resulting in piping and erosion. Other construction practices, like rolling exposed ground and slopes to a firm and smooth condition at the close of daily operations is also common and effective.

The outlet of drainage facility RD/WQ-DR-3 would be routed to the existing discharge point for road run-off in the DR-3 sub-basin. Discharge from the Mallard Lake stormwater facility WQ-ML-2 would be near the existing discharge point in Salmon Creek 1 wetland (White Center Pond). The potential for erosion at the outlet of these facilities could be reduced by tightlining outfalls downslope of erosion hazard areas and using energy dissipaters. The potential for seepage or piping through the sides and bottoms of the water quality pond could be avoided by lining the stormwater control and water quality ponds located upslope of erosion hazard areas.

Landslide Hazards and Steep Slope Hazards

As noted above, the Sensitive Areas Map Folio does not identify any landslide or steep slope hazard areas on the site. Potential areas were identified in the field, however, on the basis of slope gradient, soil type, ground water seepage and the past occurrence of landslides. Steep slopes and areas potentially subject to landslides are sensitive to the same activities. As noted above, foundation design could address potential impacts.

Landslide hazard areas are located in areas of steep slope along the east and west sides of the site; please refer to Figure 3.1-5. In addition, a rockery in the southeast portion of the project site, which appears to support a thick (less than 20 feet), loose or soft to medium stiff fill section and who's construction design is not known, could represent a potential for slope failure. Steep slope areas that could be directly affected by construction include: (1) an area along the proposed stormwater discharge pipeline corridor for stormwater control facility RD-DR-2B, (2) an area less than 20 feet high west of 8th Avenue S.W. and north of S.W. 100th Street; and (3) an approximate 10-foot high steep slope hazard area in the vicinity of the artificial fill on the west side of the development.

Construction

Potential adverse effects could result from clearing, grading, increasing runoff and concentrating flow of water over steep slope areas, excessively surcharging steep slopes, or making cuts at the toe of a steep slope. However, most steep slope hazard areas lie outside of the redevelopment area and would not be directly affected by construction. The occurrence of landsliding during construction could result in property damage, project delays, and injuries or

loss of life. However, no cuts are proposed in landslide hazard areas and proposed cuts elsewhere on the project site appear to be less than about 10 feet in depth. Furthermore, grading within the project site will occur from the top down on sloped locations, rather than from the bottom up.

Construction activities within or near the potential landslide hazard area in the eastern portion of the project site could potentially impact slope stability. Destabilization during construction could be caused by concentrating runoff or ground water within the landslide hazard area, undercutting the toe of the slope, or adding excessive surcharge (fill) to the slope. Temporary, oversteepened cuts across or at the toes of slopes for road or utility trench construction could potentially result in shallow slope failures. Large cuts (10 to 15 feet) or fill embankments (over 10 feet) could result in slope destabilization, especially where loose or soft to medium stiff fill soils, shallow ground water or seepage are present. These potential impacts would be mitigated by typical and/or recommended construction practices identified in subsection 4.1.3.

Two steep slope hazard areas located in the western portion of the site appear to be underlain by artificial fill and/or glacial till (refer to figure 3.1-1). These slopes may qualify for the exemption from King County's steep slope regulations (KCC 21A.24.310(F)). Utility corridors and stormwater conveyance systems are allowed in steep slope areas and landslide hazard areas, provided development is in accordance with King County requirements. Regrading is planned to a lower slope angle for the area near 8th Avenue S.W. and north of S.W. 100th Street. Regrading the slopes would decrease the potential for a slope failure and reduce the risk of erosion. Based on available data, it appears feasible to regrade these areas or potentially to support structures founded on in-situ (i.e., in place, firm) native soil. Design criteria for regrading or foundation design would be developed during final design phase. During final design, additional studies could be accomplished to evaluate the artificial fill present along the western side of the site to improve soil conditions, as necessary.

The stormwater conveyance system for stormwater control facility RD-DR-2B would consist of an overland HDPE pipe that would follow along or near an existing swale in the southeastern portion of the property. The pipe would likely be staked to steep slope areas and would not result in significant removal of tree cover or vegetation. Therefore, it is anticipated that no significant adverse impacts would occur.

Operation

Potential impacts could result from the headward (i.e., up and into the slope) regression of landslides toward residences and utilities; the frequency and the magnitude of any slope failures would govern possible effects. Recent slope movement has been limited to raveling where the toe of the slope has been cut and oversteepened. A recent failure is present below the powerline corridor near the eastern property line. Evidence of at least one previous shallow failure was observed on steep slopes in the east-west swale in the eastern portion of the project site. Recent failures have been limited in areal extent and depth, however. The risk to the site from these shallower slides would be low; a number of events would be required over a period of several decades to produce noticeable change. Existing homes have been located in this area since approximately 1943. The underlying soil types across the development area, including the east slopes, are glacially deposited or overridden, and are dense to very dense. Typical angles of internal friction for these soils range from 38 to 40; meaning they could theoretically stand unsupported at slopes of steeper than 1 ½ H: IV. At slopes of 2 ½ H: IV (40%), significant safety factors exist in these soil types. With proper erosion protection (and

stormwater control) near the tops of such slopes, the relatively light weight residential or infrastructure development would not constitute a significant risk from slope instability. With proper foundation support techniques, buildings could be located within 10 feet of the tops of the slopes, or well inside the typical buffer/setback.

In the southeastern portion of the project site, a thick fill soil is present upslope of a rockery of unknown construction (refer to area identified as "Af" on Figure 3.1-1). Depending upon the subsurface horizontal and vertical distribution of the fill soil and the construction of the rockery, construction of a proposed residential structure at this location could load the rockery and cause it to fail.

Uncontrolled and concentrated runoff could reduce stability of slopes or cause erosion. In areas near steep slope areas, however, the proposed stormwater system would collect roof and roadway run-off and then discharge it downslope of steep slope areas. Therefore, significant run-off onto steep slopes and potential impacts are not anticipated. In addition, stormwater control and water quality facilities near steep slopes could utilize redundant systems to avoid overflow and discharge to steep slopes.

Leakage from stormwater control ponds or water quality ponds located near steep slopes could potentially affect the slopes. Lining stormwater control ponds and water quality ponds is recommended as a mitigation measure.

King County's Sensitive Areas Ordinance KCC 21A.24) establishes buffer requirements for landslide and steep slope hazard areas. A 50-foot buffer, plus a 15-foot building setback, is typically required. A landslide hazard located on a slope 40 percent or steeper may be altered, and a buffer reduced to a minimum of ten feet (or 25 feet for an erosion hazard), if King County determines, based on a special study, that the reduction will adequately protect the proposed development and the sensitive area. Preliminary geotechnical studies showing dense, over consolidated soils with high strength support a reduction in the buffer and the setback, from a technical standpoint. The SAO also allows "reconstruction, remodeling or replacement of an existing structure upon a portion of an existing impervious surface which was established pursuant to King County laws and regulations" provided that the structure is no closer than the existing structure and the existing impervious surface within the buffer or the steep slope is not expanded as a result of the reconstruction or replacement (KCC 21A.24.310.D.7). An exemption from the steep slope hazards section of the SAO (KCC 21A.24.310.F) is allowed for slopes steeper than 40 percent and less than 20 feet high, based on King County's review and concurrence of a soils report prepared by a geologist or geotechnical engineer. Approved regrading of any slope created by previous legal grading is also allowed.

Existing structures on site appear to be as close if not closer to steep slope and landslide hazard areas than proposed structures. In addition, grass-covered areas are present close to, if not next to, the upslope limit of the steep slope and/or landslide hazard areas. Run-off from existing roofs currently runs off onto the ground surface without use of gutters, downspouts or splashblocks and over steep slopes and landslide hazard areas. Reduced buffers for the proposed structures may be justified based on the proposed drainage system, since run-off from roofs will be collected and routed into stormwater control facilities. Although there could be an increase in impervious surface area within the buffer relative to existing conditions, run-off would be collected and there would likely be a reduction in run-off and infiltration into the ground surface near the sensitive slopes. Therefore, impacts would not likely occur.

It appears to be feasible to engineer and construct new buildings using reduced buffers as indicated on the Proposed Master Plan. A preliminary analysis of the slope stability conditions as described previously, demonstrates that the site soils are dense and possess high strength, thereby reducing risks from instability and supporting reduced buffers and setbacks. Existing structures, which have been in place since 1943, have not been impacted by steep slope or landslide hazard areas. To provide specific guidance, however, special studies would be warranted as part of final design to evaluate slopes steeper than 40 percent and greater than 20 feet in height. Such studies would evaluate global slope stability and/or develop geotechnical design criteria for foundations that extend below the depth of potential slope failure.

The Demonstration Ordinance (section 1.D.8) also permits modifications or waivers from SAO requirements if the modification results in a net improvement to the functions of the sensitive area. Such an improvement would likely occur. Currently, the site is developed at urban densities and does not provide stormwater detention; roof run-off flows off the edges onto the ground surface. Run-off from the site likely increased after deforestation and land clearing at the time of initial site development and construction of Park Lake Homes in the 1940s. Along the east side of the project, the proposed stormwater system would capture roof run-off and route it into the stormwater control system. Landscaped areas present near steep slope areas would disperse run-off not collected into the stormwater system. As part of final design, surface drainage within the buffer area could also be routed into the stormwater control facilities.

Other criteria in the Demonstration Ordinance for SAO modifications or waivers relate to using natural site characteristics to protect natural systems; addressing stormwater and drainage safety, function, appearance, environmental protection, and maintainability based upon sound engineering judgment; contributes to achievement of two-star or a three-star rating for the project under the Built Green "Green Communities" program; and/or reduces housing costs without decreasing environmental protection. The Proposed Master Plan could satisfy some or all of these criteria.

Seismic Hazards

The intensity of ground shaking at the project site as a result of an earthquake could be severe because of proximity of the Seattle fault, potential for other shallow crustal earthquakes and the Cascadia Subduction zone. Potential significant impacts from seismic events would be restricted to areas underlain by artificial fill and saturated recessional outwash/ice contact deposits mapped in the low-lying area along the 8th Avenue S.W. corridor in the central portion of the site and landslide hazard areas. The primary impacts could consist of building or pavement settlement, buckling or damage to buried utilities, and possibly temporary loss of road access. Liquefaction potential generally depends upon soil type, depth to water table and soil density within 50 feet of the ground surface. The presence of these conditions across the site appears to be limited and inconsequential.

Another potential impact would be from landsliding triggered by seismic shaking. This risk would be restricted to the areas described above as potential landslide areas. No development is proposed in these areas, with the exception of the outlet pipe for the stormwater facilities from RD-DR-2B. The conveyance facility would consist of an overland pipe routed to the base of the slope. Please refer to the discussion of buffers in the steep slope and landslide hazard subsections.

Construction

While the general impacts described above could occur during construction, the likelihood is considered to be very low.

Operation

A low risk of liquefaction exists in thin layers of fine to medium sands within the fill and ice-contact deposits in the vicinity of the community buildings. Strong shaking should be anticipated across the project site. Landsliding could occur in the steep slope/landslide hazard areas along the eastern side of the project site during a seismic event. If not mitigated, areas of thick fill close to steep slope/landslide hazard areas may be susceptible to failure. Areas of artificial fill adjacent to steep slopes are present in the southeastern portion of the site, upslope of a rockery, and on the western side of the site.

4.1.2 Impacts of the Alternatives

Design Alternative Master Plan

The Design Alternative Master Plan includes earthwork that would be comparable to the Proposed Master Plan. In general, impacts to the Earth would be similar to the Proposed Master Plan.

Erosion Hazards

Construction

More grading would occur and greater area would be disturbed under the Design Alternative Master Plan. Impacts would be similar overall.

Operation

Impacts would be similar to the Proposed Master Plan.

Landslide Hazards and Steep Slope Hazards

Construction

In general, potential landslide hazard impacts would be similar to the Proposed Master Plan. However, a significant difference is that an embankment may be constructed to provide roadway connection between the southeastern and northeastern portions of the project site. This embankment would also provide the area needed to develop larger stormwater control facilities for the Duwamish River sub-basin DR-2. The embankment may encroach on steep slope areas that would require a variance. In addition, the location and height of the embankment would be challenging from a construction perspective.

Design of the embankment downslope of the Duwamish Basin stormwater quality and detention ponds, would require specific analyses to evaluate constructability, stability and to provide geotechnical design criteria for construction. It may be necessary to reinforce the slope by

using methods such as mechanically reinforced earth or constructing a retaining wall. The embankment may also encroach on steep slopes that are greater than 20 feet in height.

Operation

In general, operation impacts would be similar to the Proposed Master Plan. Run-off from the roadway and overflow or seepage from the stormwater control facilities could cause erosion and/or destabilization of the embankment proposed along the east side of the project. Lining of stormwater facilities could reduce seepage. Redundant outfall systems or inlets to outfalls could reduce the potential for overflow of stormwater control facilities. Proposals to reduce buffers in several locations would be evaluated pursuant to requirements in the sensitive areas ordinance.

Stormwater control and water quality facilities would be larger under the Design Alternative Master Plan because the stormwater management system would have limited or nonexistent infiltration. To maintain sufficient area for residential development, the two ponds for the Duwamish River sub-basin DR-2 would be located closer to steep slopes, including the steep slope created by constructing the embankment discussed above. Liners may be required for stormwater control and water quality facilities upslope of the embankment.

The wet pond on the west side of the site would be larger and, to maintain sufficient area for residential development, would likely encroach on a limited area of steep slope. Assuming till soils are present, it may be feasible to construct the wet pond as proposed. The need for a lining may be addressed during final design.

Run-off from the roadway and overflow or seepage from the stormwater control facilities could cause erosion and/or destabilization of the embankment proposed along the east side of the project. Seepage or overflow from the stormwater facility on the western side of the property may also impact erosion hazard areas or an isolated area of steep slope. The final design could incorporate redundant outfall systems or inlets to outfalls.

See discussion above regarding the proposed embankment. If not properly designed and constructed, the embankment could settle or fail. Special studies will be needed in connection with design to evaluate the proposed embankment. The height of the embankment will require specific analyses to evaluate constructability, stability and to provide geotechnical design criteria for construction. It may be necessary to reinforce the slope by using methods such as mechanically reinforced earth or constructing a retaining wall.

Seismic Hazards

Construction

Potential impacts would be similar to the Proposed Master Plan.

Operation

Potential impacts would be similar to the Proposed Master Plan. In addition, if not properly designed and constructed, the embankment proposed for the roadway connecting the northeastern and southeastern portions of the proposal may become unstable during a seismic event. The height of the embankment will require specific analyses that also include seismic loading considerations.

No Action Alternative

No redevelopment would occur and no earthwork activities would be performed. In general, construction impacts relating to erosion hazards, steep slopes, and landslide hazards would not occur. Drainage from existing homes' roofs would continue to flow onto the steep slope to the east. Existing structures are not built to current seismic code standards and could be more susceptible to damage from ground movement during a seismic event.

4.1.3 Mitigation Measures

To mitigate potential impacts to earth resources, the Proposed Master Plan and the Design Alternative Master Plan incorporate design elements specifically intended to avoid or minimize impacts to geologically sensitive areas. Development areas are generally located on the upland areas of the site away from the majority of the sensitive areas. The primary strategy employed in design of the proposed development is one of avoidance of sensitive areas. Typical buffers for steep slopes and landslide areas will be utilized with a few exceptions and those exceptions would be supported by technical analysis. Proposed design elements include stormwater facility design and implementation of best management practices to mitigate or minimize potential impacts due to development.

Best Management Practices will include development of a site-specific temporary erosion and sedimentation control plan (TESCP) for the Proposed Master Plan and the Design Alternative Master Plan. The following general mitigation measures would be implemented for the Proposed Master Plan:

- A temporary erosion and sedimentation control plan (TESCP) will be implemented. The TESCP may include a combination of interceptor swales, straw bale barriers, silt fences, and straw mulch for temporary protection of exposed soils.
- Structures could be supported on shallow foundations bearing on suitable, organic-free medium dense or dense native soil or structural fill in areas where no fill or compressible peat underlie the planned building areas.
- Building areas underlain by fill and/or compressible peat could be supported by replacing these materials with structural fill, using conventional spread footings with deep foundation stem walls founded on suitable soil or structural fill at a depth below the fill and/or peat, or be supported on deep foundations consisting of drilled aggregate piers or auger-cast piles that extend through the fill and peat and are terminated in medium dense to dense native soil.
- On-site excavated native till, ice contact deposits and artificial fill soil consisting of silty sand and sandy silt with gravel may be considered for use as structural fill for placement during periods of dry weather, provided the soil can be properly moisture conditioned to achieve adequate compaction. This use of excavated soil as on-site fill could substantially reduce the estimated number of off-site truck trips required to complete the earthwork.
- Permanent slopes should be designed no steeper than 2 horizontal to 1 vertical, and be blended into existing slopes with smooth transitions.
- Foundations and structures should be designed and constructed in accordance with the UBC standards for Seismic Zone 3. A S_B soil profile should apply to most of the site where till or dense recessional outwash/ice-contact deposits are present. A S_F profile

may apply to limited fill areas in the central part of the site. Further exploration of this condition is required during design.

- Assuming light loads, it may be feasible to mitigate for liquefaction by using pile supported foundations, using ground modification techniques such as ground densification or the installation of stone columns, or founding structures on mat foundations constructed on a structural fill pad.

Erosion Hazards

Construction

Clearing in an erosion hazard area is only allowed from April 1 through September 1 per King County sensitive area regulations. A temporary erosion and sedimentation control plan (TESCP) detailing specific locations for engineered erosion control measures is required for development in erosion-prone areas and will be developed. Erosion control measures comprising the TESCP will be specifically developed to address the individual causes and sources of erosion and sedimentation associated with the proposed project. Both erosion control and sediment control measures will be included.

The erosion control system will include redundancies or backup protection such that no single element of the system is relied upon to completely control erosion and sedimentation. The system will be regularly monitored and maintained. Qualified personnel will perform monitoring. Provisions for modifications to the erosion control system, based on monitoring observations, will be included in the TESCP. The TESCP will be designed in accordance with the KCSWDM and other applicable King County and State of Washington standards. The plan will incorporate the following basic planning principles:

- Schedule the grading and construction to minimize soil exposure.
- Retain existing vegetation whenever feasible.
- Vegetate and mulch denuded areas.
- Direct runoff away from denuded areas.
- Minimize length and steepness of slopes.
- Keep runoff velocities low.
- Prepare drainageways and outlets to handle concentrated or increased runoff.
- Trap sediment on site.
- Inspect and maintain control measures frequently.

While a slight increase in turbidity in runoff from the site would occur during wet periods while earthwork is ongoing, the increase will not be significant and is expected to be within the increase permitted by NPDES requirements.

Operation

Most erosion hazard areas within the Greenbridge site are located outside of the proposed development areas, and direct disturbance of these areas would be avoided. The Proposed Master Plan and the Design Alternative Master Plan both include collection of runoff from roadways and roof drains into a stormwater system to prevent uncontrolled runoff from flowing onto erosion hazard areas. The designs also include landscaped areas that would help disperse surface water runoff and trap sediment.

In the Proposed Master Plan, run-off from roadways will sheet-flow to continuous biofiltration swales, and roof-drains will be routed to perforated stub-out drains within sub-basin DR-2. Clean water from these two systems would then be collected and conveyed in a closed pipe system to detention facilities east of 4th Ave. Southwest. The proposed outlet for RD-DR-2B will be tightlined to the base of the slope. The outlet could utilize an energy dissipater to reduce erosion. The outlet for the detention/water quality vault in Duwamish River sub-basin DR-3 will discharge to the surface where existing run-off is routed. Because of erosion present farther downslope and the potential that surface water will pond upslope of an access road for the powerline corridor, the proposal could include a provision to construct a tightline conveyance facility to the 30-inch storm pipe flowing toward Meyers Way. An energy dissipater could also be utilized at the outlet for the Mallard Lake WQ-ML-2.

Similar measures to route outfalls downslope of steep slope and landslide hazard areas and utilization of energy dissipaters could be used for the Design Alternate Master Plan.

It is anticipated that the proposed stormwater runoff control systems, and controlled discharge rates will adequately minimize erosion and sedimentation following build-out, if properly maintained. Tightline outfalls and energy dissipaters could be beneficial if included in the final design of stormwater facilities.

It is anticipated that potential impacts to the erosion areas within or adjacent to the development area will be avoided or appropriately mitigated by incorporating and properly implementing the design elements described above. Direct disturbance of large portions of erosion hazard areas will be avoided by the proposed development layout.

Steep Slope Hazards

Construction

Typical mitigation of impacts in or near steep slope and landslide hazard areas resulting from project development will include some or all of the following:

- Minimize concentration of surface water discharge on or near steep slopes or landslide hazard areas.
- Intercept and direct surface water to a stabilized discharge outlet.
- Reduce clearing to the minimum extent necessary.
- Implement bench-cut slopes.
- Constrain earthwork to dry weather.
- Specifically designed structures to support or retain exposed soil in cuts or fills within steep slope areas.
- Free-draining structural fill in roadway or utility corridor embankments to accommodate round water seepage.
- Final designs for retaining walls and other structural designs must accommodate perched ground water and seepage.
- Revegetate disturbed areas as soon as practicable.

Specific measures will include an approved TESCP to control runoff during construction.

Plans for regrading steep slopes within the development area should be reviewed by a licensed geotechnical engineer during the final design phase. Steep slope hazard areas within the development boundaries are less than 20 feet in height and most will be regraded to flatter slopes during mass grading, which will increase slope stability and reduce the potential for erosion. No fill will be placed on or near the crest of steep slope areas. Run-off water will be routed away from steep slope areas or erosion control measures will control water that could flow onto steep slopes.

Operation

Most of the steep slope areas lie outside of the proposed development area, so direct impacts from construction will be avoided. Most of the steep slopes that lie within the development area will be regraded to more stable slope configurations.

Any steep slopes created as a result of grading (i.e., cut or fill slopes) and remaining after development will be assessed for appropriate buffers and setbacks and/or structurally designed or reinforced as required to provide adequate stability. The Design Alternative Master Plan includes an embankment in the central-eastern portion of the site, which will require additional study in the context of design.

Runoff from roadways, roofs, driveways and other impervious surfaces adjacent to steep slope hazard areas will be collected and routed to the stormwater system under the Proposed Master Plan and the Design Alternate Master Plan.

Buffers and setbacks for steep slope hazard areas would generally follow King County standards. Initial studies support a reduction in the standard buffer; site specific studies would be conducted as part of project design to confirm the specific requirements. Several lots in the southeast portion of the study area will require special studies to evaluate appropriate setbacks and may include special foundation consideration.

Both the Proposed Master Plan and the Design Alternative Master Plan should consider lining stormwater ponds and water quality ponds located near steep slopes to reduce seepage. In addition, consideration should be given to include redundant outfalls or redundant inlets to outfalls to reduce the potential for overflow onto steep slopes.

For the Design Alternative Master Plan, special studies will be required in conjunction with design for the embankment proposed in the east-central portion of the site. The proposed fill section is anticipated to be over 20 feet high and may encroach on steep slope and landslide hazard areas (though the fill would act as a buttress).

Erosion/sedimentation control measures, stormwater runoff control and special design elements to prevent concentration of subsurface interflow will help prevent decreases in slope stability and erosion.

It is anticipated that the planned elements of the alternatives adequately address the issues described above or that the issues can be resolved by completing additional analysis in the context of design. Therefore, it is anticipated that no significant adverse impacts to steep slope hazards will occur from the proposed development alternatives or to the development from steep slope hazards.

Landslide Hazards

The Proposed Master Plan and Design Alternative Master Plan would include avoidance of landslide hazard areas, an approved TESCP as described above, buffers and building setbacks. In addition, all runoff from new roadways within the development will be collected and routed to approved stormwater systems. Specific design features will be based on special studies as needed; these studies will be conducted during the final design stage. Specific areas requiring special studies include any proposed reductions in buffers.

Construction

Construction mitigation measures applicable to both the Master Plan and the Design Alternative Master Plan are described above under the section on Steep Slopes. The landslide hazard areas lie outside of the proposed development area, so direct impacts from construction will be avoided. Mitigation of indirect impacts are also described above in the Steep Slope section.

Operation

Runoff from roadways and roofs adjacent to landslide hazard areas would be collected and routed to the stormwater system under the Proposed Master Plan and the Design Alternate Master Plan. It is anticipated that no post-development impact to landslide hazard areas from these sources of surface run-off.

Buffers and setbacks for landslide hazard areas would generally follow King County standards (50 feet and 15 feet respectively). Initial studies indicate it will be possible to reduce the standard buffer consistent with criteria in the SAO or Demonstration Ordinance. Several lots in the southeast portion of the study area may require special studies, pursuant to the SAO, to further evaluate proposed setbacks and to identify appropriate foundation considerations. These studies would be performed during final design. For the Design Alternative Master Plan, special studies pursuant to the SAO would also be required for the embankment proposed in the east-central portion of the site (see the Steep Slope mitigation discussion above).

For the Proposed Master Plan, design criteria for structures in the area of fill upslope of the rockery located in the southeast portion of the site, could be developed as part of final design.

The residual significant adverse impacts to landslide hazard areas from development elements or impacts to the development from landslide hazards are, in the geotechnical consultant's opinion, low. Surface water will be controlled during and post-development, steep slope and landslide hazard areas will be primarily avoided and protected with adequate buffers, and special site-specific studies will provide data to mitigate or minimize adverse significant impacts during the final design phase.

Seismic Hazards

Mitigation for seismic hazards will be similar for both the Proposed Master Plan and the Design Alternative Master Plan. Based on review of the available data, it is GeoEngineers opinion that there is a low potential for liquefaction in the area where artificial fill is mapped in the low-lying area of 8th Avenue S.W. Further studies could be completed in conjunction with final design to further evaluate the extent of fill soils and potential saturated recessional/ice-contact deposits.

Assuming light loads, it may be feasible to mitigate for liquefaction by using pile supported foundations, using ground modification techniques such as ground densification or the installation of stone columns, or founding structures on mat foundations constructed on a structural fill pad. Special studies will be required during final design, once a foundation system is selected.

No significant adverse impacts are anticipated to the proposed development from seismic hazards, either through avoidance or through proper design and construction, based on the special studies outlined above.

4.1.4 Significant Unavoidable Adverse Impacts

No significant unavoidable adverse impacts to earth resources are anticipated from the Proposed Master Plan or the Design Alternative Master Plan.